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Arctic mountain arch as a place of great glaciers slipping in the Late Pleistocene

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ABSTRACT
Modern tectonic structure of the Arctic deep-water basin based on the analysis of geographic and geological maps of the Northern Hemisphere and the existing literature is shown. High mountain character of the Arctic territory and the great glaciers' traffic during the Pleistocene (500–20 thousand years ago) are shown. On this basis, it is concluded that slipping of the great glaciers occurred from mountain system of Greenland – Lomonosov. In the early Holocene (10-7 thousand years ago), south part of this mountain range was immersed along large vertical faults before the depths 4-5 km.

Keywords: Northern hemisphere, Neocene–Pleistocene, Arctic mountain arch, movement of glaciers, immersing mountains.

1. SCIENTIFIC NOVELTY

First shows the main movement of the great glaciers in the Northern hemisphere, in the Pleistocene, with the Central Arctic (Greenland–Lomonosov) alpine system. In the Holocene (10–7 thousand years ago) southern part of it was immersed to great depths (4–5 km). Now it is the Arctic deep water basin. So far, there is a representation of a plurality of the glaciers' centers - the Alps, Scandinavia, Appalachian et al., and even the site of the Central Arctic Basin (Sokolovsky et al., 2011) but the main path of the great glaciers have not been determined and not discussed today.

2. MATERIALS AND METHODS

Materials for the study are based on geographic maps of the Northern hemisphere, the data on the earth crust's cyclical descending -ascending vertical movements in the Arctic and existing publications on the prevalence of the glaciers in the Pleistocene and the structure of them. The main method of research - synthesis received new data and critical analysis of existing concepts.

3. RESULT

3.1 Conditions of formation and existence glaciers

Glaciers are natural accumulations of large masses of ice, formed in areas of land, where the quantity of snowfall exceeds the decline of its melting. Currently, about 11% of the land is covered by glaciers. Powerful icecap (1-2 km) hides the Antarctica's island; it is a single icy continent. In the Northern Hemisphere, the largest island of Greenland is 85% covered by a powerful (up to 3 km) ice sheet. In Russia, the Arctic Ocean's islands (Severnaya Zemlya, Franz Josef Land, etc.) almost completely covered with glaciers. In the temperate and tropical latitudes glaciers cover only the tops of high mountains. At the equator, lower snow limit is at a height of 4.4–4.9 km above sea level, in the Alps – at a height of 2.5 to 3.2 km. On the north side of the mountains the border of the snow line is lower than on the south side of them. In the Himalaya, for example, the boundary of the snow covers at 1.7 km lower relative to its position on the south side. Constant position of the snow line is determined by two factors as a whole - from the heights of the mountains above sea level and the distance to the polar region with the lowest annual temperature. In particular - are areas with an average annual temperature of the warmest month is not more than 5 ° C (Serpukhov et al., 1976).

There are glaciers as a covers and mountain glaciers. Ice sheet cover the large areas and are in relative rest, in a flat relief. Mountain glaciers are usually slipping from the high mountains along the river valleys, reaching a large length. For example, the Fedchenko Glacier in the Western Pamir reaches a length of 77 km with thickness of 550 m.

In the areas of long-term accumulation of snow small snowflakes in a snow mass crystallize into larger crystals and grain and sealed. A dense firn ice formed in this way. Weight 1 m^3 of snow is 85 kg, 1 m^3 firn is 500 kg and 1 m^3 of glacial ice is 900 – 950 kg (Serpukhov et al., 1976).

Ice plastic and in a sloping terrain begins to flow down the hill, thus creating a glacier. Glaciers are used primarily ready-reduced form in its motion - river valleys, and all sorts of reduced depression. When warming, the glacier begins to melt and shorten, i.e. retreat. The velocity of the mountain glaciers is 40–100 meters per year, some large Greenland glaciers are moving faster – up to 5–40 meters per day (Serpukhov et al., 1976).

3.2. Changes in the relief resulting from the glacier's movement

As usual flowing rivers, glaciers in its motion produces a great job of destruction, transport and deposition of the trapped rocks. The process of destruction of rocks – glacial erosion or exaration (from the Latin exaratio –turn inside out) appears on the ground in different forms. Glacier thickness layer while moving skinned (cuts) soft rock in the bed and in the lateral parts, forming pits of different size and depth. The most typical forms are the following.

1. Formation of the broad glacial carved valleys and glacial troughs. These forms are characterized by the motion of mountain glaciers.
2. The formation of deep basins later filled with water and become glacial lakes and large marshes. These forms are characterized by the motion of sheet glaciers.
3. The deposition of the material trapped in the movement of the glacier at the end of glacier movement and melting it. They have the form of moraines and drumplins. Drumplins are narrow (100–150 m), low hills (25 m) length of several kilometers in the direction of the glacier's movement and composed of heterogeneous clay and clastic material. Moraine are a large hills and low mountains a large extent, generated on the site of the termination of the glacier's moving, after melting it. For example, the Valdai Hills in the center of the Russia's European part, formed at the end of the large Valdai glacial period during the late Pleistocene (20 thousand years ago). The Valdai Hills length of about 800 km and 250 km width, the height of the individual rolling mountains to 200–293 m. To the east is the Volga Uplands of glacial origin, length of 500 km.
4. Glacial dislocations. They are widely distributed in all areas of the big glaciations, folded soft sedimentary rocks. Most often they occur in areas where bedrock is raised and constitute an obstacle for the glacier's movement. In these cases, soft rock bent and formed numerous small scaly thrusts. These glacial dislocations are known in many places of the European plains, in Sweden and North America (Hain, 1964).

Hard rocks destroyed by the movement of glaciers otherwise. They are characterized by "mutton foreheads", exotic boulders and fjords.

1. Hard rocks usually abraded from the surface and become smooth polished dome-shaped hills with scratches and grooves on the surface, elongated in the direction of the glacier. They are called "mutton foreheads".
2. From hard rocks often break out large blocks. They smooth out the motion of the glacier and deposited at a great distance from their place of primary occurrence, in the areas of occurrence of an entirely different rocks. These brought about glacier large boulders called "exotic boulders."
3. . Fjords - a narrow, long (200 km) and deep (up to 1 km) sea bays in coast of mainland and islands. They are formed in hard rock due to glacial erosion of the coast along the transverse valleys of the rivers and the individual tectonic faults.

3.3. Great glaciations of the Northern Hemisphere in the Late Pleistocene

At the beginning of the Cenozoic there was a very warm climate in the world almost on the entire surface of the planet. The subtropical climate was in the middle latitudes - in Europe, North America, and moderately warm climate was in the areas of modern Arctic - in Greenland and in the territory of modern Arctic islands.

In Paleocene and Neocene there was a warm climate, but gradually had been cooled from 22 to 15° C. During the Pliocene epoch (3 million years) the climate became much colder - the average annual temperature has decreased by 13°C (from 15° C to 2° C). In Quaternary established a rapid and dramatic alternation of low and high average temperatures with the general trend to lower the temperature at 5-7° C (Figure 1) is relatively of modern (Rosenbaum, Shpolyanskaya, 2000).

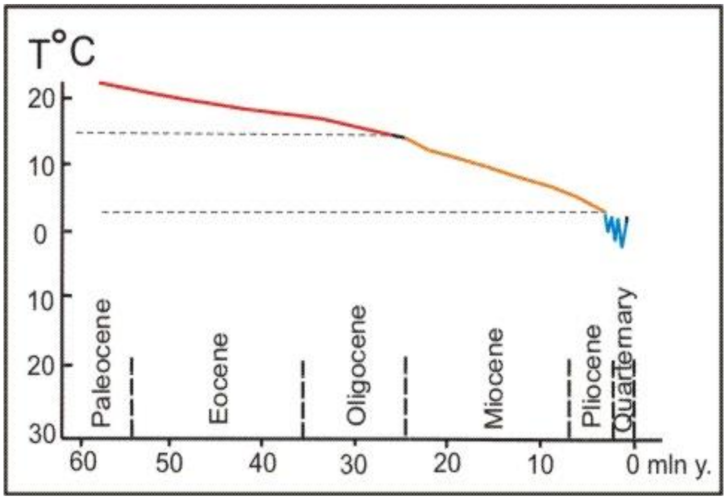

Figure 1
Graph of average temperatures change in Europe over the past 65 million. y. By P. Voldshtedt (Gavrilov, 1986).

As a result of the sharp drop in temperatures in the Northern Hemisphere have grown huge, powerful (2-3 km) glaciers, which began to spread to the south on the vast territory - from the Arctic to the south (48-50° north latitude), over a distance of 3-5 thousand km. Glaciers reached latitude of the Don and the Dnieper River, to southern Europe and to the Mississippi River middle, that to south of the Great Lakes in North America (Figure 2).

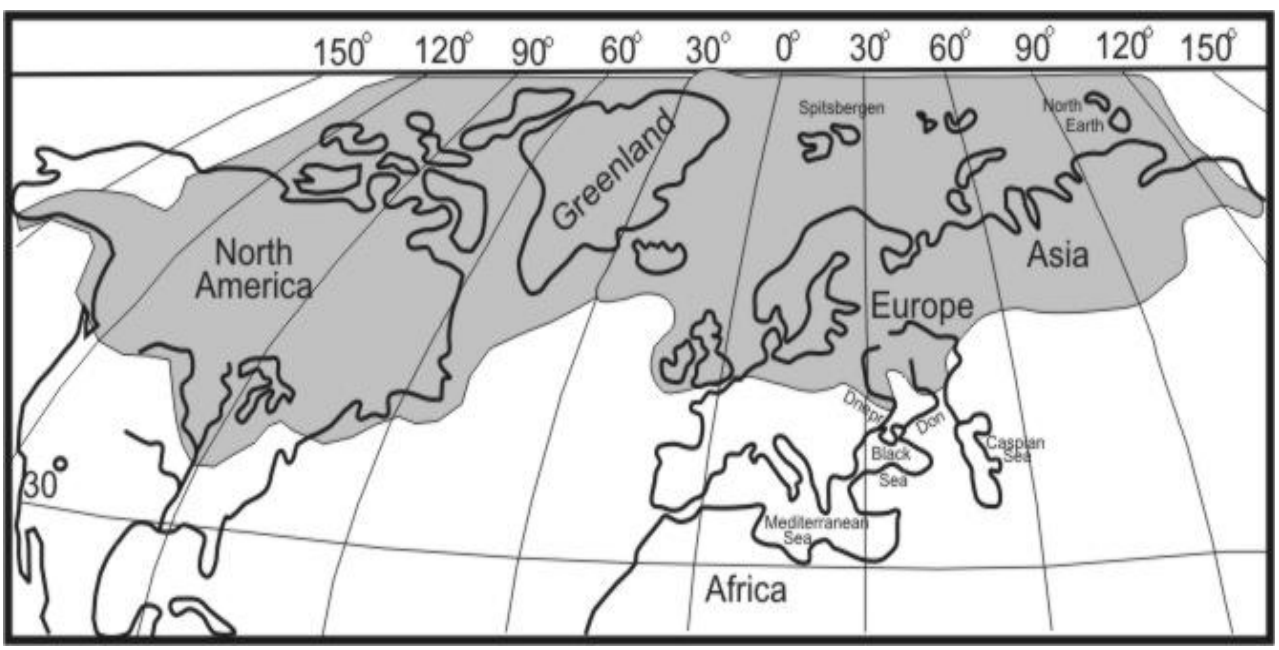

Figure 2
The maximum extent of the glaciers in the Northern Hemisphere in Quarternary period. (Lewites, 1986; Gavrilov, 1986; Sokolovsky et al., 2011)

There are three epoch of maximum glaciations: In Western Europe - Mindel (0.5–0.4 million. y.), Riss (0.25–0.15 mln. y.) and Wurm (70–12 thousand y.). In the European part of Russia, they correspond: Oka, Dnieper and Valdai glacial epochs. Power glaciers reached 2-3 km, and in the Arctic (near the island of Novaya Zemlya) - up to 4 km (Gavrilov, 1986).

Extremely harsh conditions characterized the last phase of the Valdai glaciation – 20-18 thousand years ago when global temperatures were below current 5-7° C (Rosenbaum, Shpolyanskaya, 2000). During the period of 14–6 thousand Years ago, there is a warming climate, melting and retreat of glaciers (Serpukhov et al., 1976; Rosenbaum, Shpolyanskaya, 2000; Kotlyakov, Velichko, 2014). All modern Arctic shelves represented at the time (20–10 thous. Years ago) dry land and continental Mainland Eurasia had been bordered directly with the territory of modern Nansen Basin and had been connected with the southern ends of the Lomonosov and Mendeleev's ridges. Only after melting of the main body glaciers (10-7 thous. years ago), when the climate became warmer modern temporarily at 6-7º C, dry Arctic plain was flooded with water, resulting in an Arctic modern shallow (20-150m to 400-600 meters in some places) Shelf (Koronovsky, 2011; Kotlyakov, Velichko, 2014).

A clear judgment on the main center of the glaciers' occurrence is not expressed. There is a representation of a plurality of centers of glaciations – in the Alps, in Scandinavia, on the island of Novaya Zemlya in the Arctic, Greenland, in the Cordillera and elsewhere (Serpukhov et al., 1976; Lewites, 1986; Koronovsky, 2011).

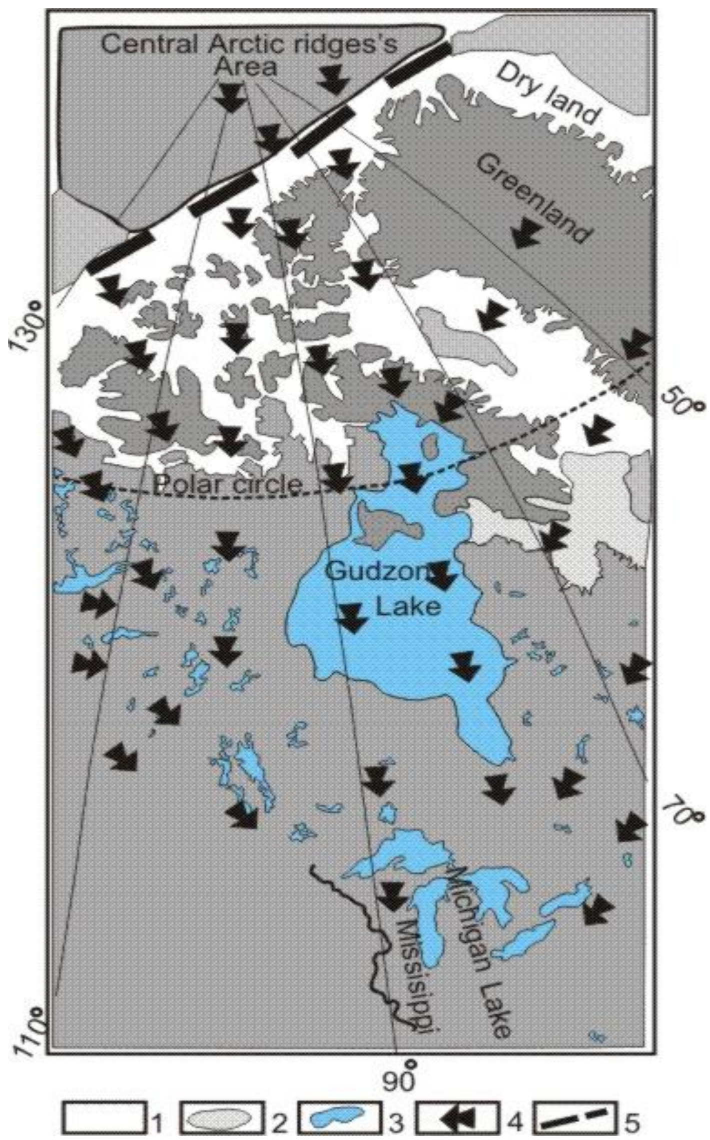

Figure 3

Traces of glaciers' movement in relief of North America (Atlas..., 1982)

1 - The area of the modern shelf;

2 - modern deep ocean bays and some sea;

3 - lakes;
4 - the directions of glaciers movement;
5 - North Greenland fault.

3.4. Main directions of the Great Glaciers' movement in North America and North Eurasia

Driving Directions glaciers can restore their traces left on the ground. Among the most informative features of this kind, detectable on maps even smaller scale, are the fjords and lakes, to a lesser extent - the glacial moraines and "exotic" boulders. On the map of North America and framing its Arctic islands north of these signs clearly expressed (Figure 3).

The North American continent has a specific surface. He is represented by the huge central plain surrounded by high mountains from the flanks. High ranges with peaks of up to 2-3 km, located in the north of the continent, in the northern part of the largest islands – Greenland, Ellesmere, Baffin Island, and on the west of the territory – the Mackenzie Mountains and the Rocky Mountains. The Great Plain is bounded on the south-east of the Appalachian mountain system with heights at the level of 1.4–1.6 km. High mountain terrain on the north of the continent, near the North Pole, has led to the formation on it powerful glacier. Ways sliding glaciers in the Late Pleistocene were also caused by high altitude of this area.

The main path of the glaciers clearly traced meridional chain of islands and channels within the Canadian Arctic Archipelago, large lakes Hudson, Michigan and Huron, and the valley of the Misssisipi large river, elongated in the meridional direction. The chain of small lakes to the west of Lake Hudson points to the path of another glacier. The depth of large lakes reaches 208–281 m (Soviet ..., 1980). The northern mountainous parts of the Greenland and Ellesmere islands cut by a large series of deep fjords. This indicates that the largest glacier started at the area located to the north of these islands – from the area of the Lomonosov and Al'fa–Mendeleev ridges in the modern Arctic basin. Power glacier was 2-3 km, as evidenced by the power of the modern glacier in Greenland (Koronovsky, 2011).

The presence of a series of deep fjords in the north-eastern part of Baffin Island indicates to the movement of ice from Greenland. A series of diagonal lakes in Canada and the United States indicates on the additional glaciers from the Mackenzie Mountain and Rocky Mountains to the west and the Appalachian Mountains to the east (Figure 3). Glaciers covered most of the Great Plains to the middle Mississippi river. During the Veyshon last glaciations (12 thousand years ago), the power of the glaciers on the southern flank of the front was already small, about 100m (King, 1969).

The movement of glaciers in the territory of Northern Eurasia also clearly expressed in the present relief (Figure 4).

The extensive development of the fjords in the north-western outskirts of the islands of Iceland, Ireland, Britain, and in the western part of Scandinavia, suggests the movement of glaciers in the Greenland's south-eastern mountainous part. On the eastern side of Eurasia deep fjords are widespread in the northern part of the peninsula Scandinavia and on the Arctic islands Svalbard and Severnaya Zemlya, located in proximity to the Nansen Basin and the Gakkel Ridge in the north. It is clear that the movement of glaciers started in the north with the area occupied by the modern deep-water basin.

Before large island of Franz Josef, located between these Arctic islands and folded soft rocks of Mesozoic age, was almost wiped from the surface of a huge glacier. In its place remained only the set (190) is very small and low islands. The largest island of Novaya Zemlya was strongly clipped on the flanks of the moving glacier. He gained sharply elongated shape, oriented parallel to the movement of the glacier (Figure 4).

The path of motion of a glacier in the northern part of the Russian Plain traced a series of many lakes. They were formed on the sites of the local pits, glaciers carved out of rock along the path of its movement to the south.

Further south, near Moscow and in the area between the Don and the Dnieper, there were large hill - moraine (200-300 m high) – Valdai and other (Fig. 4). They are composed of glacial clay and breccias which were left on the place of stop and the melting of the last glacier Valdai (about 14–10 thousand years ago). Belts of huge moraine hills stretch for hundreds of kilometers (Nalivkin, 1980).

The data on the ways of the great movement of glaciers in North America and northern Eurasia clearly indicate the start of the movement of glaciers to the Polar region – the northern part of the now underwater Lomonosov and Mendeleev ridges and the south-western part of these ranges, as well as with the now underwater Gakkel Ridge.

3.5. Modern geomorphologic and tectonic structure of the Arctic territory

The value of surface relief for the understanding of its geological structure is extremely important. Great Austrian geologist Eduard Seuss, in his monumental work "The Face of the Earth» (Seuss, 1909), first identified the extraordinary dependence of terrestrial relief from internal structure of the crust and the processes of its development (Udintsev, 1987). This applies to any part of the globe, including, to the territory of the Arctic. The current structure of the Arctic area is shown in Figure 5.

The tectonic structure of the Arctic territory was defined in the last 60 years, thanks to systematic research in the Arctic, held at the annual drifting stations and individual expeditions for special projects. It turned out that the Arctic Ocean - education considerably younger, emerged recently.

In General this is a very large graben – gorst with a set of concentric-radial arrangement of the main geomorphologic elements and major faults. Three main geomorphologic structure are established in it structure. The outer incomplete ring of arch is represented of modern continents' outskirts. This landscape has mountains and some small plains. To the north is the island of Greenland, the Canadian Arctic islands and Alaska North America. The south part of Arch it is Eurasian continent's north part.

Second, domestic - intermediate, semi-ring is shallow (20–150m) plain shelf, which is on the south side of Eurasia has a great width, up to 1100 km. In the west, in the area of the Greenland-European Sea "corridor", in particular on the 'threshold' of Thomson (Scottish Iceland-lifting bottom), the depth of the shelf reaches 400-600 m (figure 5). On the slopes of the underwater continental ridges (to west and north-west from Iceland's island) reaches 2-3 km (Atlas..., 1982; Udintsev, 1987; figure 5).

The inside part of the arch is represented of the Central Arctic basin. It is separated from Greenland and the Canadian Arctic Archipelago of North Greenland regional faults. In the southwest, the basin is bordered along the fault to the north-eastern boundary of the continental bottom of Barents and Kara Seas. Three small deep-water seas are in the western part, in the sea "corridor" between Greenland and the Scandinavian Peninsula. This is the Norwegian-Greenland deep basin (Udintsev, 1987). The Seas of the basin is also bordered of the North Greenland regional fault, but from the opposite, north-west side. Both deep water basins form a single large basin of meridinal direction on west, north-west and south direction in the Center and north-east direction on east (Canada basin).This large deep water basin is the central core of the great Arctic arch. It occupies a diametrical position relatively of the direction Atlantic Ocean's north part (to north-west of the Iceland's island).

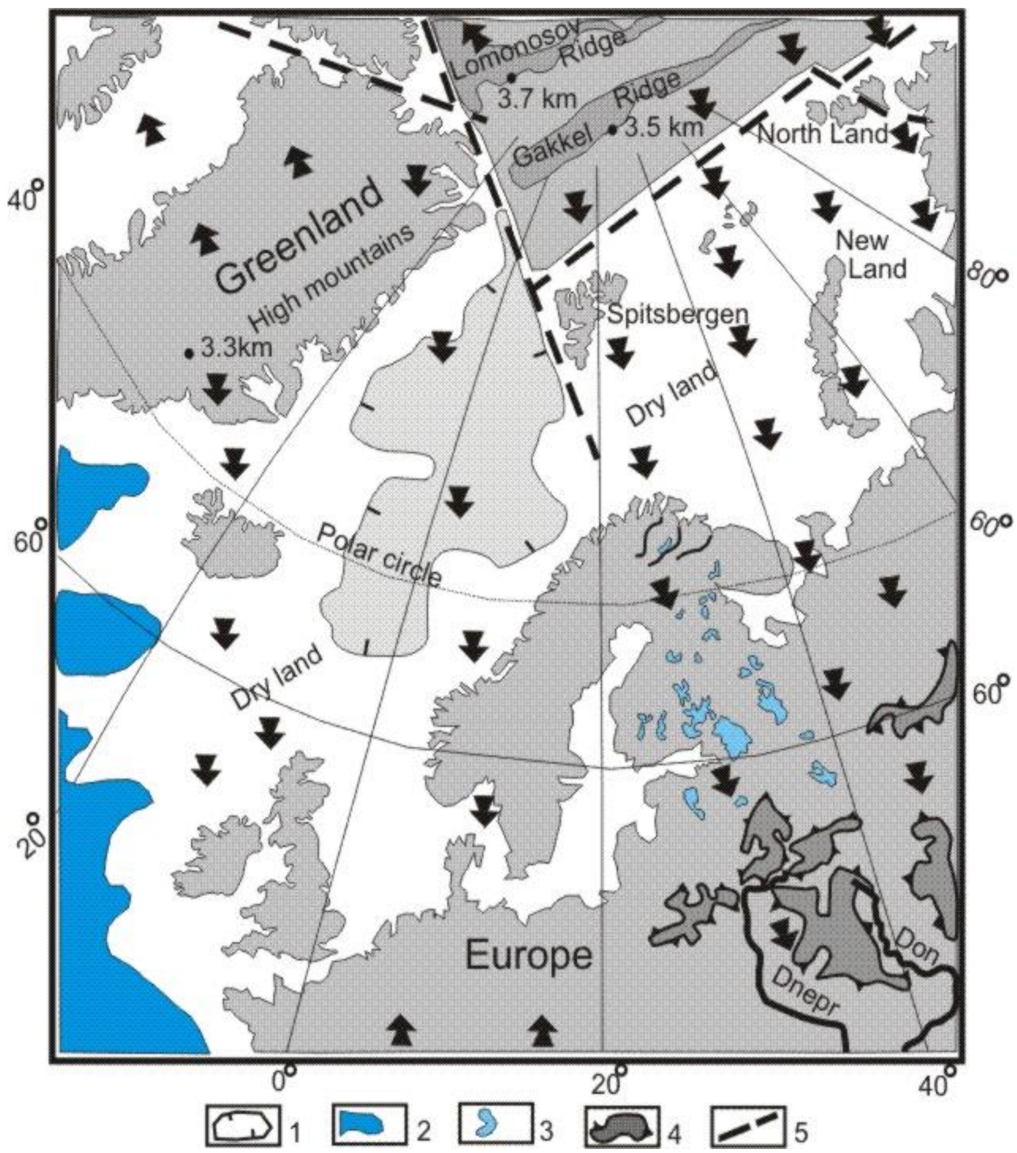

Figure 4

Traces of glacier's movement (black arrows) in the relief of Northern Eurasia

1 – Shallow basin;

2 –Atlantic Ocean's bays;

3 - lakes in the north of the Russian Plain;

4 –glacier's moraine deposits;

5 - some major faults.

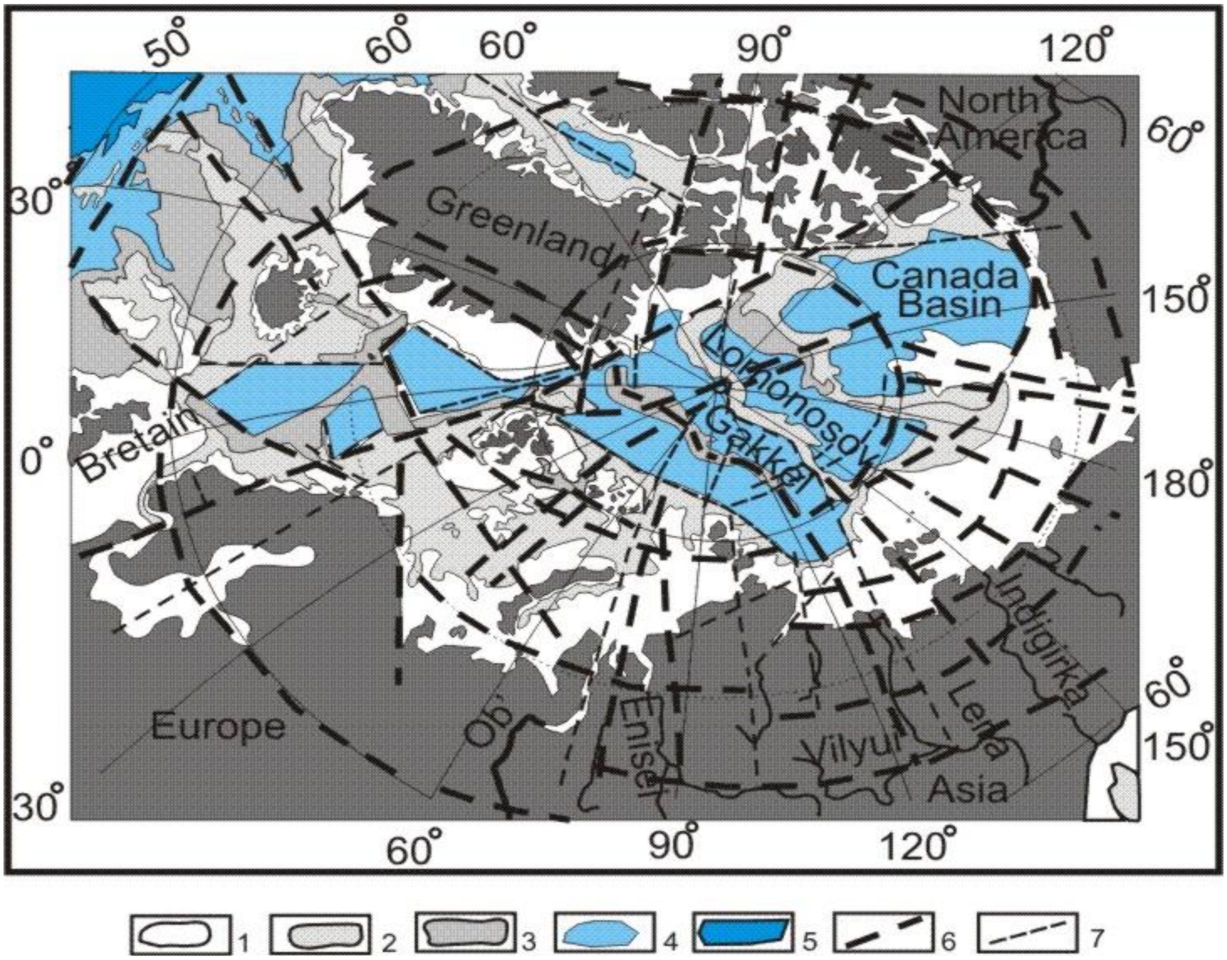

Figure 5
Modern geomorphologic and tectonic structure of the ArcticTerritory.
In view of the data (Atlas..., 1984; Udintsev, 1987; Arkhangelskay, 1998; Gramberg, Naryshkin, 2000; Pavlenkin, Poselova, 2006; Zhirnov, 2014).
1 - shallow (20-200 m) shelf;
2 – deep water (0.4-1 km) shelf;
3 - continental slopes of underwater ridges (1-3 km);
4 –Central Arctic basin;
5 – Atlantic ocean;
6 - large faults;
7- smaller faults.

The whole area is dissected by numerous large faults, and a ring-shaped radial faults relatively described Center-ring structure. Many of them are described in the literature (Hain, 1963; Favorskaja et al., 1974; Favorskaja, 1980; Poletaev 1994; Arkhangel'skaia, 1998; Starosel'tsev, 2007; Zhirnov, 2008). Some additional faults identified by the author now.

Deep hollows and ridges of the Arctic Basin have been studied extensively over the past 50 years, scientific institutions and the Ministry of Geology of theRussia, as well as - foreign researchers. According to many years of bathymetric and seismic surveys, underwater topography of the Arctic basin is studied in sufficient detail (Udintsev, 1987; Gramberg, Naryshkin, 2000; Piskarev, 2004; et al.). It structure is shown in Figure 6.

Arctic basin is shaped like a smooth triangle, bounded on the north-east of the North Greenland fault, on the south-east - a broad shallow shelf of Asia’s boundary, on the south-west - even border of the Barents and Kara Seas’ shallow shelf. It consists of two structurally distinct parts - the southern part of a group of closely spaced parallel depressions and ridges, and the north-eastern part, represented by the Canadian Basin.

In the southern part of the basin, a group of narrow, closely spaced deep depressions north-west strike are Depression Nansen, Amundsen Basin and Makarov – Submariners Basin, separated by narrow mountain ridges – Gakkel, Lomonosov and Alpha-

Mendeleev. They form a single structural group, and characterized by its smooth and parallel borders, testify to their single tectonic origin. The width of the group corresponds to the width of Greenland. The ridges' group is the south-eastern underwater extension of it.

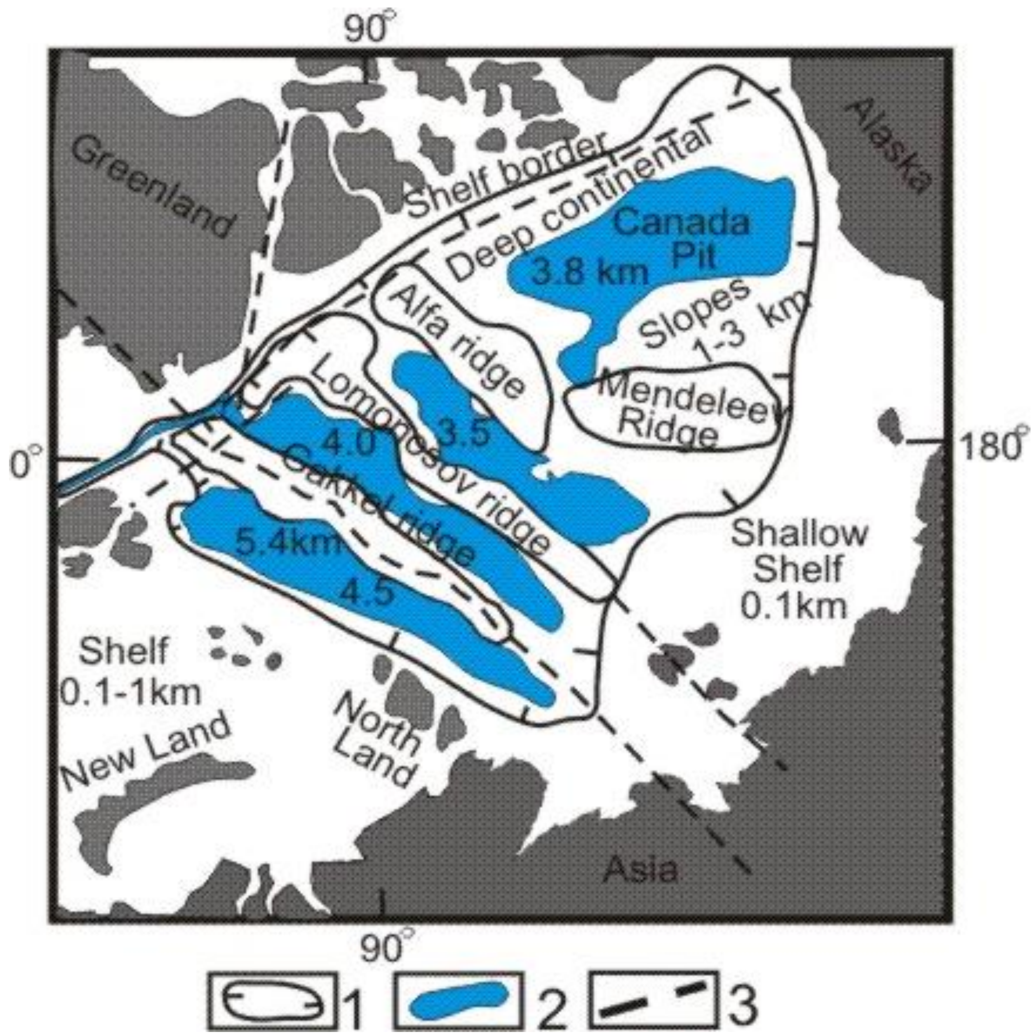

Figure 6
Central Arctic Basin's relief**.** According to **(**Udintsev, 1987; Gramberg, Naryshkin, 2000).
1 - The border of the Central Arctic Basin;
2 - deep depression;
3 - some faults.

In the north-eastern part of the basin is deep Canadian Basin, structurally separate from the above discussion group troughs and ridges. This trough has a cross, north-west direction and has wide stretch slopes of the continental shelf from surrounding continents to the bottom of the basin. The relief of the bottom of the Central Arctic Basin is shown in Figure 7.

A characteristic feature is the presence of underwater topography and steep sub vertical scarps height of 2-3 km, on the borders of the shelf of the Barents Sea with the Nansen Basin, on the slopes of the Gakkel Ridge, the Lomonosov and Alpha ridges (Figure 7). These scarps are understood as tectonic faults, which could occur along the vertical displacements of rock blocks (Udintsev 1987; Pavlenkin, Poselova, 2006).

The top parts of the Lomonosov Ridge and the Mendeleev-Alpha are covered with a thin horizontal layer (0.5-1 km) of unconsolidated sedimentary rocks with seismic velocity of 1.8 -2.3 km / sec, conventionally attributed to the Cenozoic. Cretaceous age of them is more probable, judging by the finds fragments of sedimentary rocks of Cretaceous age on the slopes of the Lomonosov Ridge. In the top layer of rocks on the Alpha ridge are found basalts' fragments of the Late Cretaceous (83 million Years ago), covered with a thin layer of Quaternary clays (Kaban'kov et al., 2004).

If we exclude from the boundaries of the Arctic basin wide plains of the Eurasian and American continents, flooding recently (about 8 thousand Years ago), after the melting of the great glaciers), according to (Kotlyakov, Velichko, 2014) then the Central Arctic deep depression is a common the continental sea¸ like Black or Mediterranean Sea in the South Europe.

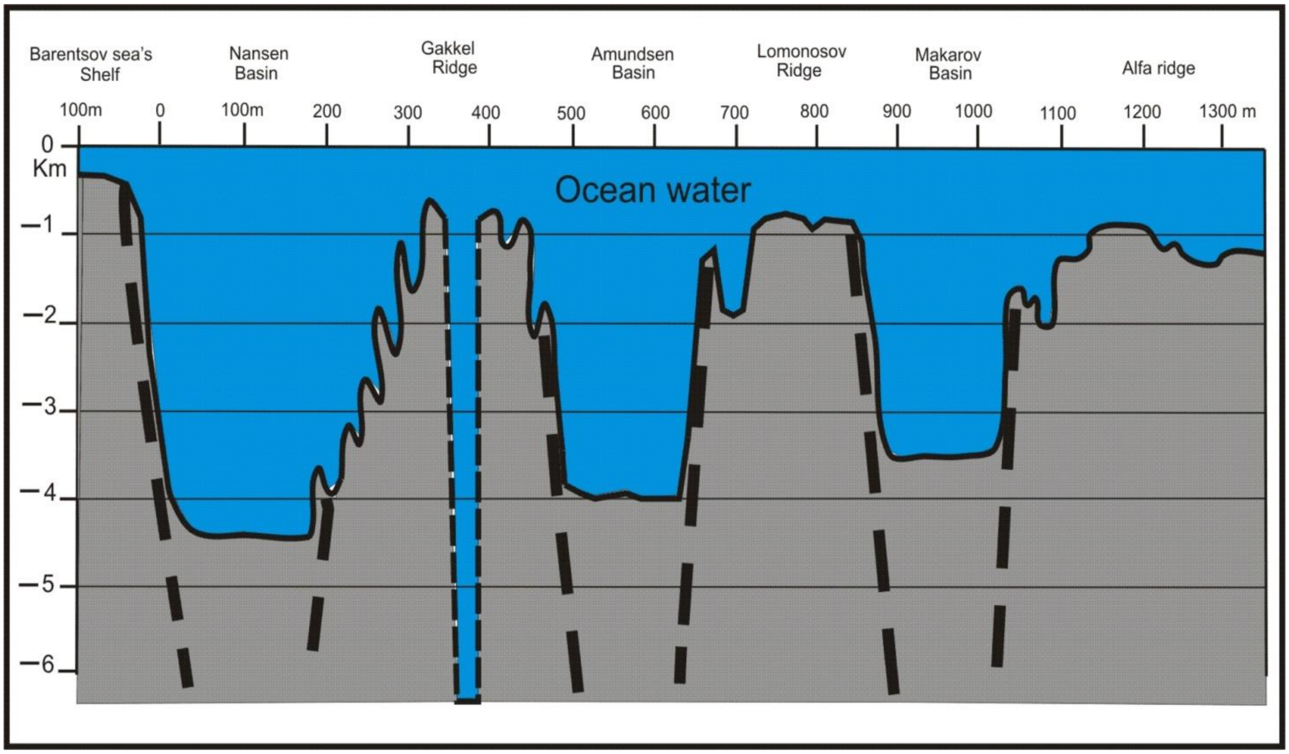

Figure 7
Underwater mountain ranges in the Central Arctic Basin**.** According to (Gramberg, Naryshkin, 2000; Piskarev, 2004; Pavlenkin, Poselova, 2006).

Since the Arctic deep water basin, both within the continental sea, completely surrounded by land masses, neither of which "spreading" in it, ie, about the formation of deep basins by a horizontal divergence of blocks rocks (as is often said in the press) is not out of the question (Udintsev, 1987; Belousov, 1989). There can only be vertical upward and downward movement of the blocks rocks, ie, forming gorsts and grabens, as evidenced by the presence of numerous vertical faults (Fig. 7) on the sides of submarine ridges and troughs (Pavlenkin, Poselova, 2006).

Formation of deep grabens in the Central Arctic, at the beginning of the Holocene, is consistent with the overall sharp dip the bottom of the oceans in the Cenozoic, with 0.5 -1 km in the Cretaceous to 5-6 km in the late Cenozoic, followed by sudden instant collapse of individual blocks of rocks at 0.5-2 km. In this way were formed deep (2-5 km) stepped grabens filled with sea water, for example, in the Black Sea and the Mediterranean Sea (Belousov, 1989; Pavlenkin, Poselova, 2006; Orlenok, 2012).

3.6. Alpine nature of Central Arctic territories in the Cenozoic

The northern part of the Eurasian Continent was flooded by sea in the Jurassic – Cretaceous. By the end of the Paleogene it rises and becomes Alpine dry land. Marine Paleogene and Neogene sediments are absent in all the islands of the Arctic territory (Nalivkin, 1980). Neogen-Anthropogenic time - this time the final stage Alpine tectonic cycle when ascending and descending the vertical tectonic movements have gained the most widespread and largest scale, both on the territory of the modern oceans, and the continents (Hain, 1964). So at the end of the Paleogene - early Neogene on the site of modern deep-sea basins emerged land and the Gakkel Ridge, also the Lomonosov and Alpha-Mendeleev ridges towered high (4-5 km) over this land. It was a great alpine Arctic arch (Fig. 8).

Consequently, the territory of modern Eurasian shelf had a slope from alpine Arctic arch in the direction of the Eurasian continent, as is the case now in the territory of Greenland.

In the mid-late Pleistocene, when on the Earth came a sharp cooling of the climate, the Arctic arch (Greenland mountain range with the Central Arctic ridges) became the site of a giant glacier formation (Fig. 9). After reaching the height of a glacier more than 2-3 km, began an irreversible slide of glaciers from the north to the south, over long distances (Fig. 2-4, 8).

However, after the last Valdai (Wurm - in Western Europe, Wisconsin – in North America) glaciations, near 15-10 thousand Years ago, it began warming climate and melting glaciers. In the early Holocene (10-7 thousand years ago) there have been rapid collapse of block rocks in south part of the Arctic arch and the formation grabens, later filled sea water. In this way, the modern Central Arctic deep water basin was formed.

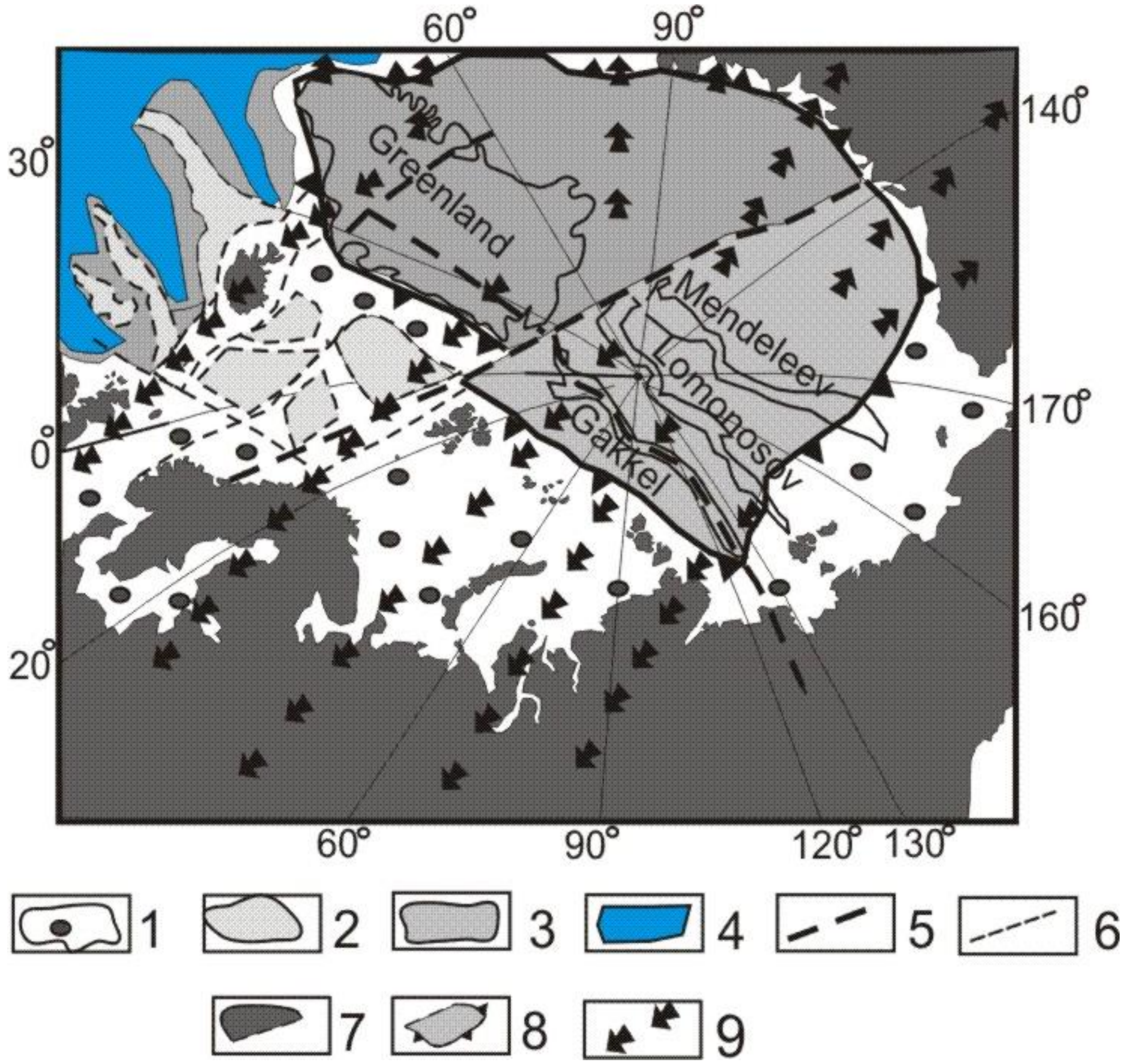

Figure 8
Arctic Alpine arch of the Earth in the Neogene-Pleistocene. Compiled by the author based on the data (Udintsev, 1987; Belousov, 1989; Kaban'kov et al., 2004; Pavlenkin, Poselova, 2004; Rosenbaum, Shpolyanskaya, 2004; Kotlyakov, Velichko, 2014).
1 – dry land, the site of the modern shelf;
2 - shallow basins;
3 - continental slopes of underwater ridges;
4 - Bays of Atlantic Ocean;
5 - some major faults;
6 – smaller faults;
7 - the territory of the modern continents;
8 – Arctic Alpine arch;
9 – the directions of the great glaciers' movement in Pleistocene from the Arctic arch's axis.

4. DISCUSSION

In the concentric structure of the Arctic territory, due to the annular arrangement of the ancient Paleozoic and Mesozoic sedimentary basins around the ledge of the Archean basement (Greenland – block Amundsen and Nansen), pay attention to many researchers (Shatsky, 1935; Eardley, 1954; Puscharovsaky, 1960; Pogrebitsky 1976; Nalivkin 1980; Pavlenkin, Poselova. 2006; et al.). In the Paleozoic-Mesozoic time the sea existed on the site of today's underwater Lomonosov and Mendeleev-Alpha ridges (Kaban'kov et al., 2004). But by the Neogene the Alpine Arctic arch was originated at the site of modern Central Arctic deep-water basin. Later this arch collapsed on the vertical fractures to form deep grabens (Pogrebitsky, 1976; Pavlenkin, Poselova, 2006). Many other

modern deep seas – the Black Sea, the Mediterranean Sea, formed in Neocene-Pleistocene in this way (Pushcharovsky, 1960; Belousov, 1989, Serpukhov et al., 1976).

At the site of the Black Sea, for example, 15 thousand years ago, there was a shallow lake, the water level of which was 120 m below Ocean level. Tectonic events in the area of the Mediterranean Sea, at the turn of 7500-7000 years ago, led to the formation of deep basins in the Mediterranean and Black Seas, the formation of Bosporus and Dardanelles straits and the formation of the modern image of the Seas (Kholodov, 2014). The formation of deep basins occurred by collapse on vertical faults, as evidenced by the marine terraces at different depths of the Black Sea (Serpukhov et al., 1976; Belousov, 1989). An example of a recent large-scale collapse along a vertical faults can serve as immediate immersion in 200m quay in Lissabon (Portugal) in 1755 (Serpukhov et el.,1976).

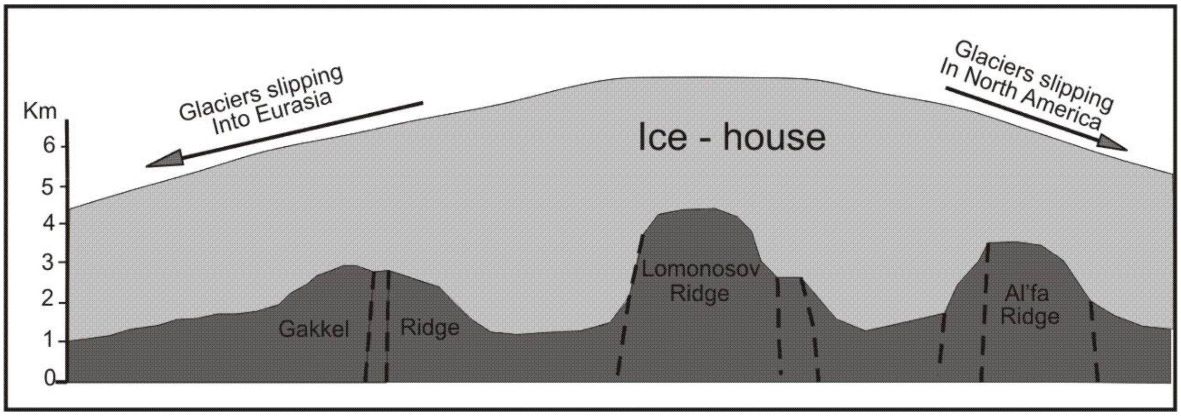

Figure 9
Cross-section of the primary glaciers in Central Arctic in Pleistocene.
Compiled by the author based on the data (Udintsev, 1987; Belousov, 1989; Pavlenkin, Poselova, 2004; Rosenbaum, Shpolyanskaya, 2004).

Apparently, the formation of the Mediterranean and Black Seas were simultaneously with the formation of deep basins in the Central Arctic.

The data given in this article on the Great Glaciers' movement allowed defining the place central highlands where they began their grand movement in the south. This will more accurately determine the time of occurrence of the deep basins in the Central Arctic and the Arctic Ocean as a whole - about 10–7 thousand years ago. Exactly then ended the melting of glaciers and sea water transgression began with the formation of the modern wide of the Arctic shelf.

5. CONCLUSION

1. Amundsen-Nansen grabens with Gakkel and Lomonosov ridges together with Greenland land was Arctic alpine arch with an altitude of about 3.5-4.5 km in Neogene-Pleistocene. In place of the modern Arctic shelf was dry land.
2. In the mid-late Pleistocene in this mountainous region were formed several times powerful glaciers (2-4 km), due to a sharp cooling of the climate of the Earth. These glaciers slipping from the axis of the mining area to the south in two general areas - in North America and in Eurasia, the enormous distances - up to 3-5 thousand Km.
3. At the beginning of the Holocene (10–7 thousand Years ago), after the sharp warming and melting glaciers, started transgression of North Sea and the formation of the modern shallow Arctic shelf.
4. During the period of 8–6 thousand Years ago, large vertical tectonic faults occurred. Arctic mountain area was broken into pieces and lowered deep (4–5 km) in a series of grabens. Modern deep-water basins, Central Arctic and Norwegian-Greenland, appeared this way.

SUMMARY OF RESEARTH

1.In the Neogene-Pleistocene Arctic alpine area existed on the site of the modern Arctic deep-water basin.
2.Huge power (3-4 km) glacier formed in Arctic mountains in the Late Pleistocene due to a sharp cooling of the climate.
3.The great glaciers are three times slipping to south, in America and Eurasia, from the Arctic alpine area up to 5 thousand km covering vast areas.
4.At the beginning of the Holocene, with a sharp intensification of vertical faults and global warming climate, South Mountain Arctic was divided into parts, deeply lowered as grabens; arose water covered the surrounding plains - originated the modern Arctic Ocean.

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